The advantages of this type of manometer are readily apparent. Its range compared to that of other high vacuum gauges is very large, extending from more than 10^{-3} mm. to as low pressures as can be obtained, without any change of apparatus. On account of its simplicity of construction it is inexpensive and exactly reproducible. Since there are no moving parts there are no difficulties due to vibration. The pressures of vapors which would not be registered on the McLeod gauge are measured by the ionization manometer. One of the greatest advantages is the rapidity and ease with which measurements of a varying pressure may be made since only the reading of a galvanometer need be followed.

Many applications for which other manometers cannot readily be used at once suggest themselves, such as the measurement of vapor pressures of metals, etc. Since the device may be made with extremely small volume the pressure of very small quantities of gas may be measured. It would also be useful to measure pressure changes over a long period of time for which more expensive manometers could not well be employed.

A number of interesting physical measurements other than the measurement of pressure can be made with devices operating on the principle of this manometer, among which is that of the removal of occluded gases by electron bombardment. It is also hoped that experiments with various gases will give some information as to the relative cross sectional areas which different kinds of molecules present to the electron discharge, for although the constant of the manometer was found approximately the same for hydrogen, air, and mercury vapor, more exact measurements might show differences due to different molecular diameters.

PHYSIOLOGICAL STUDIES ON RHIZOPHORA

By Howard H. M. Bowman

DEPARTMENT OF BOTANY, UNIVERSITY OF PENNSYLVANIA, AND TORTUGAS LABORATORY, CARNEGIE INSTITUTION OF WASHINGTON

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Research on the physiology and ecology of the red mangrove, *Rhizophora mangle*, which has engaged my attention for the past few years, was continued at the Tortugas Laboratory of the Carnegie Institution during the summer of 1916. The phase of physiologic investigation most emphasized was that relating to the transpiration rate of *Rhizophora* seedlings grown in solutions of different concentrations of salt

water and in various soils. The mangrove, growing as it does in such peculiar conditions, in salt and fresh water alike, offers a rich field for studies on absorption and transpiration rates, the effects of chemical substances on these phenomena, and the physical relations of density of media. A brief account is here given of some of the more important observations made on the effects of these changes in media on the transpiration.

The material used was *Rhizophora* seedlings. These were selected as the most easily handled and the most readily procurable. Seedlings one to two years old, growing on shores of keys from 3 to 75 miles from the Tortugas, were secured and planted, some in Tortugas sand (a coarse sand composed of broken shell, corals, and other calcareous débris) and others in a ferruginous sandstone soil brought down from New Jersey. Another series also was planted in fine calcareous mud taken from the moat at Fort Jefferson. These cultures compose the soil series of experiments.

Another group of plants was planted in the Tortugas sand and kept in water of the following concentrations: 100, 75, 50, 20, 10, and 5% fresh, and 100% salt water. In a previous season records were taken on plants grown in hyperconcentrated sea-water, 140% salt. The record for these plants gave a very slow rate of growth, and after lingering for a few weeks, the plants yellowed, dropped the leaves, and died. These experiments were not repeated.

In all these cultures the plants were grown in large 10-inch beakers and the water was siphoned off every day and a fresh solution was put on. This was found to be necessary to keep algæ and mosquito larvæ out of the cultures and also to simulate the tidal action in daily bringing a fresh supply of water to the plants, as in their natural habitat.

Still another group of cultures was made of plants kept in various light intensities as well as moisture conditions. One class was kept in New Jersey soil in partial shade with 100% salt water; another in partial shade, New Jersey soil, 50% salt water; a third class, kept in partial shade in shell sand, merely moistened with 100% salt water; a fourth class was kept in partial shade in New Jersey soil, merely moistened with 100% salt; and a fifth class in full sun all day long, planted in shell sand and kept moist with 100% salt water.

This last class was in a condition which most nearly approximates the natural environment of *Rhizophora* seedlings cast up by the waves on a coral strand in the Gulf region. The tides bury the hypocotyl or it bores a resting-place by the radicular end twirling in the water-current and often becomes entirely covered with sand. Leaves are put

out as long as the source of moisture in the sand is constant and there is enough reserve food in the hypocotyl, but the tiny leaves are soon burned up by the fierce sunlight and the drying winds. This putting out of leaves happens repeatedly until the little seedling is exhausted and it succumbs to the hard conditions on the beach. The same thing occurred in the full-sun cultures, so that no leaves could be secured on which to take transpiration records.

The method of securing the records was that of Stahl—that is, a colorimetric method. A Ganong leaf-clasp was employed and the rate of transpiration was measured in minutes and seconds until the cobalt chloride paper in the clasp was changed to a uniform pink, due to the water given off through the epidermis of the leaf, chiefly that of the lower surface, as there are no stomata on the upper surface. Potometer records were also taken, but on account of the limited amount of cultures this method was not feasible. The plants in the soil and water concentration cultures could have repeated tests taken on them by the Stahl method, whereas for a potometer record a plant would have had to be sacrificed for every reading. The readings were taken mostly during the middle portion of the day, to secure as uniform conditions as possible. Some potometer records were made to check up results and to get some quantitative idea of the amounts of water really transpired.

In tabulating the results of this work it is found that by plotting these transpiration readings (given below in part) with the time intervals as ordinates and the concentration percentages as abscissæ, a parabolic curve is described. The following is a statement of the solution concentrations and transpiration intervals:

Series A, 100 per cent fresh, 1.6 minutes
Series B, 75 per cent fresh, 1.7 minutes
Series C, 50 per cent fresh, 2.4 minutes
Series D, 20 per cent fresh, 2.8 minutes
Series E, 10 per cent fresh, 3.2 minutes
Series F, 5 per cent fresh, 3.9 minutes
Series G, 100 per cent salt, 4.1 minutes

By applying the formula $Y = CX^n$, the constant being the initial quantity of water needed to affect the transpirometer, it is also deduced that the additional time required for the transpiration of equal quantities of water is due to the retarding effect of progressively higher salt concentration of the medium—that is, the time factor is a function of the square of the concentration divided by a constant. In other words, the rate of transpiration varies directly with the concentration of the medium in which the *Rhizophora* plants grow.

For the soils series of experiments the data show that the most striking phenomenon is the accelerating effect on the transpiration due to the soil from Maplewood, New Jersey. It is assumed that this accelerating effect is due to chemical action, the New Jersey soil having a larger number of elements in it, and others in greater amount (viz., iron, aluminium, and silica) than in the shell sand of the Tortugas, in which calcium carbonate preponderates. Though, unfortunately, the range of data is not wide enough on the New Jersey soil to produce a full curve, there is enough to show that the segment paralleled the parabola of the shell sand curve, which curve is expressed with the concentration of the water being constant for both soils.

Another interesting point, illustrated in this latter plotting, particularly of the data secured on the cultures which were kept merely moist with the salt water, was the demonstration of the physiological law that the smaller the quantity of available moisture the slower the transpiration. Of course, this was only to be expected, but the clarity of the evidence presented in this case was a pleasant surprise to the investigator, inasmuch as he was only indirectly concerned with the water available for absorption.

Casual mention may here be made also of a series of biochemical tests conducted on *Rhizophora* hypocotyls this summer, to determine the relations of the amounts of tannic acid and dextrose in these organs; and also to demonstrate, if possible, the presence of the enzyme tannase —broadly, to learn something of the rôle of tannin, which is so abundant in *Rhizophora* in nearly all its tissues. This work, while merely started, presents a very interesting field of investigation, since it is supposed that some tannins of the plastic group probably contribute to the nutrition of the plants containing them. It is hoped to continue work on this problem, since the knowledge of the function of tannins in the plant economy is rather obscure, and generally they are supposed to be merely excretory products. On account of the paucity of data in this research the writer does not feel justified in making a definite statement regarding the relation of the amounts of tannic acid and dextrose in the *Rhizophora* hypocotyl; at present, however, it may be safely said, on the strength of over 50 tests for tannase, conducted according to the usual methods of enzyme tests, that this enzyme could not be detected in the hypocotyl of *Rhizophora*.